

CLAIMS

What is claimed is:

1. An apparatus for aligning optical fibers in a 2-dimensional array, comprising:

- a) a plurality of etched sticks, each stick having a notch and a front surface, wherein the etched sticks are stacked so that the notch forms a cage;
- b) an optical fiber disposed in the cage and oriented perpendicular to the front surface;

wherein the notches have surfaces that are directional dry etched sidewall surfaces formed by directional dry etching perpendicular to the front surface.

2. The apparatus of claim 1 wherein the etched sticks have top and bottom surfaces, and the top and bottom surfaces are directional dry etched sidewall surfaces.
3. The apparatus of claim 1 wherein the etched sticks have top and bottom surfaces, and the top and bottom surfaces are cleaved surfaces.
4. The apparatus of claim 3 wherein the sticks are stacked so that adjacent cleaved surfaces on adjacent sticks are complementary.
5. The apparatus of claim 1 wherein directional dry etched surfaces are undercut less than 1 degree.
6. The apparatus of claim 1 wherein the etched sticks are made of silicon and are diffusion bonded together.

7. The apparatus of claim 1 wherein the etched sticks have top and bottom surfaces, and the top and bottom surfaces each have at least one notch.

5 8. The apparatus of claim 1 wherein the etched sticks have top and bottom surfaces, and the bottom surface of at least one etched stick does not have a notch.

9. The apparatus of claim 1 wherein the etched sticks have a thickness in the range of 300-1000 microns.

10 10. The apparatus of claim 1 wherein the etched sticks have flanges in the range of 1-20 millimeters long.

11. The apparatus of claim 1 wherein the etched sticks have alignment holes.

12. The apparatus of claim 11 further comprising alignment rods disposed in the alignment holes.

13. The apparatus of claim 1 wherein the sticks have positive and negative lateral alignment features.

14. The apparatus of claim 13 wherein the lateral alignment features are designed so that the sticks are separated by a gap 53.

15. The apparatus of claim 1 wherein the sticks are bonded by spin-on-glass.

16. The apparatus of claim 1 wherein at least one stick has a pit 21 in the front surface.

17. The apparatus of claim 1 wherein at least one stick has a groove in the front surface.

18. The apparatus of claim 1 wherein at least one etched stick is a double-sided stick having:

- a) a front portion;
- b) a rear portion;

wherein the notch extends through the front portion and the rear portion, and

- c) an etch stop layer disposed between the front portion and the rear portion, wherein the etch stop layer is bonded to the front portion and the rear portion.

19. The apparatus of claim 18 wherein the front portion and the rear portion each have a thickness in the range of 300-1000 microns.

20. An apparatus for aligning optical fibers in a 2-dimensional array, comprising:

- a) a plurality of etched sticks each having a notch and a front surface, wherein the etched sticks are stacked so that the notch forms a cage;
- b) an optical fiber disposed in the cage and oriented perpendicular to the front surface;

wherein the etched sticks have top and bottom surfaces, and the top and bottom surfaces are cleaved surfaces.

21. The apparatus of claim 20 wherein the sticks are stacked so that adjacent cleaved surfaces on adjacent sticks are complementary.

22. The apparatus of claim 20 wherein the etched sticks are made of silicon and are diffusion bonded together.
23. The apparatus of claim 20 wherein the etched sticks have top and bottom surfaces, and the top and bottom surfaces each have at least one notch.
24. The apparatus of claim 20 wherein the etched sticks have top and bottom surfaces, and the bottom surface of at least one etched stick does not have a notch.
25. The apparatus of claim 20 wherein the etched sticks have a thickness in the range of 300-1000 microns.
26. The apparatus of claim 20 wherein the etched sticks have flanges at least 1 millimeter long.
27. The apparatus of claim 20 wherein the etched sticks have alignment holes.
28. The apparatus of claim 27 further comprising alignment rods disposed in the alignment holes.
29. The apparatus of claim 20 wherein the notches have surfaces that are directional dry etched sidewall surfaces formed by directional dry etching perpendicular to the front surface.
30. The apparatus of claim 20 wherein the notches have surfaces that are laser drilled sidewall surfaces formed by laser drilling perpendicular to the front surface.

31. The apparatus of claim 20 wherein the notches have surfaces that are anisotropically wet etched sidewall surfaces formed by anisotropic wet etching perpendicular to the front surface, and wherein the sticks are made of single crystal silicon.

32. The apparatus of claim 20 wherein the sticks are bonded by spin-on-glass.

33. The apparatus of claim 20 wherein at least one stick has a pit **21** in the front surface.

34. The apparatus of claim 20 wherein at least one stick has a groove in the front surface.

35. The apparatus of claim 20 wherein at least one etched stick is a double-sided stick having:

a) a front portion;

b) a rear portion;

wherein the notch extends through the front portion and the rear portion, and

c) an etch stop layer disposed between the front portion and the rear portion, wherein the etch stop layer is bonded to the front portion and the rear portion.

36. The apparatus of claim 18 wherein the front portion and the rear portion each have a thickness in the range of 300-1000 microns.

37. A method for making a 2-dimensional optical fiber array, comprising the steps of:

a) forming a perforated chip having a plurality of holes located according to a 2-dimensional pattern, wherein the holes are located along lines;

~~b) cleaving the chip along the lines of holes so that the~~
perforated chip is separated into etched sticks, whereby the holes form notches in the etched sticks;

c) stacking the etched sticks with optical fibers disposed in the notches so that the optical fibers are arranged according to the 2-dimensional pattern.

38. The method of claim 37 wherein the etched sticks are stacked so that complementary cleaved surfaces are rejoined.

39. The method of claim 37 wherein step (a) is performed by directional dry etching.

40. A method for making a 2-dimensional optical fiber array, comprising the steps of:

a) directionally dry etching a plurality of etched sticks from a flat substrate, wherein each etched stick has a notch, and wherein each etched stick has top and bottom surfaces defined by a mask during directional dry etching;

b) stacking the etched sticks with optical fibers disposed in the notches so that the optical fibers are arranged according to the 2-dimensional pattern and so that the optical fibers are caged by the notches, and so that the optical fibers are oriented essentially parallel with the directional dry etching direction.

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